**Introduction**

**Research Goal:** To reduce the mass, deformation, and cost of wind turbine direct-drive generators through additive manufacturing of bio-inspired geometries.

**Additive Manufacturing—A Game Changer for Wind**

Additive Manufacturing, or three-dimensional printing, refers to a manufacturing process in which a part is built layer by layer. Advantages of additive manufacturing include less material waste, “free complexity,” and lower labor costs.

**Application to Wind Turbines**

- Generator design
- Embedded sensors
- Blades
- Hub casings
- Turbine towers
- Gearbox

**Large-Scale Metal Printing**

**Electron Beam Melting (EBM):**

- A high-power electron beam selectively melts electrically conductive metal powder
- Pros: Fast, vacuum required, low thermal stress
- Cons: Produces x-rays, few materials

**Direct Metal Laser Sintering (DMLS):**

- Focused laser beam selectively melts metal powder
- Pros: Good surface finish, high resolution
- Cons: Slow, large amount powder to fill bed

**Powder-Binder Jetting:**

- Alternating layers of sand and binder
- Build up a mold in which the desired metal is cast
- Pros: Cheap, large scale, bridge to conventional
- Cons: Rough surface finish, one use mold

**Structural Analysis**

- All bio-mimetic designs depict 60% less radial deformation
- Torsional deformations within 0.33 mm limit under torque loading for all except hollow web
- Axial deformation never exceeds critical value (30 mm)

**Conclusions**

I. Stator light weighting using lessons learned from rotor.
II. Advanced bio-mimetic designs with lattice creation
III. Improve conventional and additive manufacturing costing models

**Areas of Future Work**

I. 24% less structural mass
II. 60% less radial deformation
III. Additive manufacturing enables design for functionality Potential 40% cost savings.